SUMMARY REPORT
FOR
LIFE CYCLE ASSESSMENT FOR PROFILES

LIFE CYCLCE ASSESSMENT OF PROFILES
EXECUTIVE SUMMARY

1.0 Introduction:

The life cycle assessment study presented below illustrates the impacts of PVC profiles during its life cycle and compares the same with those of its alternatives. This study has been commissioned by the Indian Centre for Plastics in the Environment (ICPE). The study has been conducted following the ISO 14040 standards guidelines for Life Cycle Assessment.

2.0 Goal of the study:

The overall goal of the Life Cycle Assessment (LCA) study is to evaluate the impacts of PVC profiles during its life cycle vis-à-vis the competing materials, aluminium and wood.

3.0 Target Audience

The target audience is the policy makers who are involved in issuing policies related to Plastic Use and Management.

4.0 Scope of the study

The applications considered for the purpose of the study, the alternative materials considered, the functional unit and the processes/stages excluded from the scope of the study are discussed in the following sections

4.1 Applications considered

The applications considered for the study include:

- Doors
- Windows

4.2 Alternatives

The alternatives considered for comparison with PVC profiles include

- Aluminium
- Wooden

4.3 Life cycle stages

The life cycle stages considered for this study include

- Raw material production.
- Profile manufacturing
- Profile transportation.
- Use of profile
- Used profiles management.(Reuse/ Recycle/Disposal)

The modes of disposal considered for the study include landfill and incineration.

4.4 Functional unit of the study

"The production, use and disposal of profiles for a window of dimension 1.2m x 1.2m and a door of dimension 1.0 x 2.1m

4.5 Exclusions

The stages/ processes/data not included in the study are:

- Infrastructural requirements
- Manufacturing of chemicals not forming a part of the final product.
- Transportation of materials by modes other than road.
- Material input less than 1% of the total input
- Economic and socioeconomic parameters.

5.0 Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) phase involves the evaluation of potential human health and environmental impacts due to the environmental releases and depletion of resources. LCIA involves the use of science based conversion factors for calculating the impacts each environmental release has on issues such as smog or global warming. There are various methodologies available for carrying out an LCIA The criteria for the selection of the impact assessment methodology and a brief discussion on the selected methodology is presented below in the following section.

5.1 Selection of the assessment method:

Keeping in view the nature of the study, the following parameters have been decided upon for selection of the impact assessment method:

1. Completeness with respect to impact categories
2. Modeling techniques used
3. Worldwide acceptance
4. Time perspective

Keeping in line with the ISO 14040 standards guidelines, emphasis has been given on methodologies that consider higher number of impact categories. Since the study is related to comparison of the products for public assertion, assessment methods using state of the art scientific models have been preferred over methods using simpler techniques. Worldwide acceptance and time perspectives have been given a comparatively lower emphasis. Also, an impact assessment method with a balanced time perspective has been preferred for the purpose of the study.

The impact assessment methods were weighted using the above criteria and the results of the same are presented below:

Table 1.1: Decision criteria for selection of LCIA method

Impact Assessment Method	Completeness	Modeling	Acceptance	Time Perspective
Eco Indicator 99 (E)	H	H	L	L
Eco Indicator 99 (H)	H	H	L	M
Eco Indicator 99 (I)	H	H	L	L
EPS	H	H	L	L
CML 2000	N	M	L	L
EDIP	M	H	M	L

(Suitability criteria: H: High, M: Medium , L: Low, N: Not suitable)

It can be observed from **Table 1.1** that the Ecoindicator 99 methodology with a heirarchist time perspective, based on the defined criteria, stands out to be the better option.

5.2 Eco indicator 99

The damage categories across which the impacts can be evaluated using Eco Indicator 99 methodology are Human health, Ecosystem quality and Resources.

Human health:

The damage category, 'Human health', indicates the adverse impact on human health due to the release of pollutants into the environment. The impact categories included within this damage category are:

- Carcinogens
- Respirable organics
- Respirable inorganics
- Climate change
- Radiation
- Ozone layer

Ecosystem quality

Ecosystem quality indicates the adverse impact on ecosystem quality due to the release of pollutants into the environment. The impact categories included within Ecosystem quality are:

- Ecotoxicity
- Acidification / Eutrophication
- Land use

Resources:

Resources indicate the adverse impact of consumption of materials that lead to depletion of resources. The impact categories included within Resources are:

- Minerals
- Fossil fuels

5.3 Life cycle impact assessment results

The life cycle impact assessment results for the profiles are presented in the **Tables 1.2 and Table 1.3.** . **Table 1.2** presents the scores in terms of absolute scores while Table 1.3 presents the scores for the alternatives relative to PVC. **Figure 1.1** presents the impact category score while **Figure 1.2** presents the damage category score. Lower the score, superior is the environmental performance of the product.

Keeping in line with ISO 14040 standards guidelines, weighting sets have not been used and no single scores have been provided.

Table 1.2: Life cycle assessment indicator scores for profiles (Points)

Damage category	PVC	Wood	Aluminium
Human Health	0.000203	7.99E-5	0.000777
Ecosystem Quality	2.24E-5	7.17E-5	4.01E-5
Resources	0.000828	0.000842	0.00333

Table 1.3: Life cycle assessment indicator scores for profiles (%)

Damage category	PVC	Wood	Aluminium
Human Health	1	0.39	3.83
Ecosystem Quality	1	3.2	1.79
Resources	1	1.02	4.02

Figure 1.1: Life cycle assessment indicator scores for profiles (Impact category)

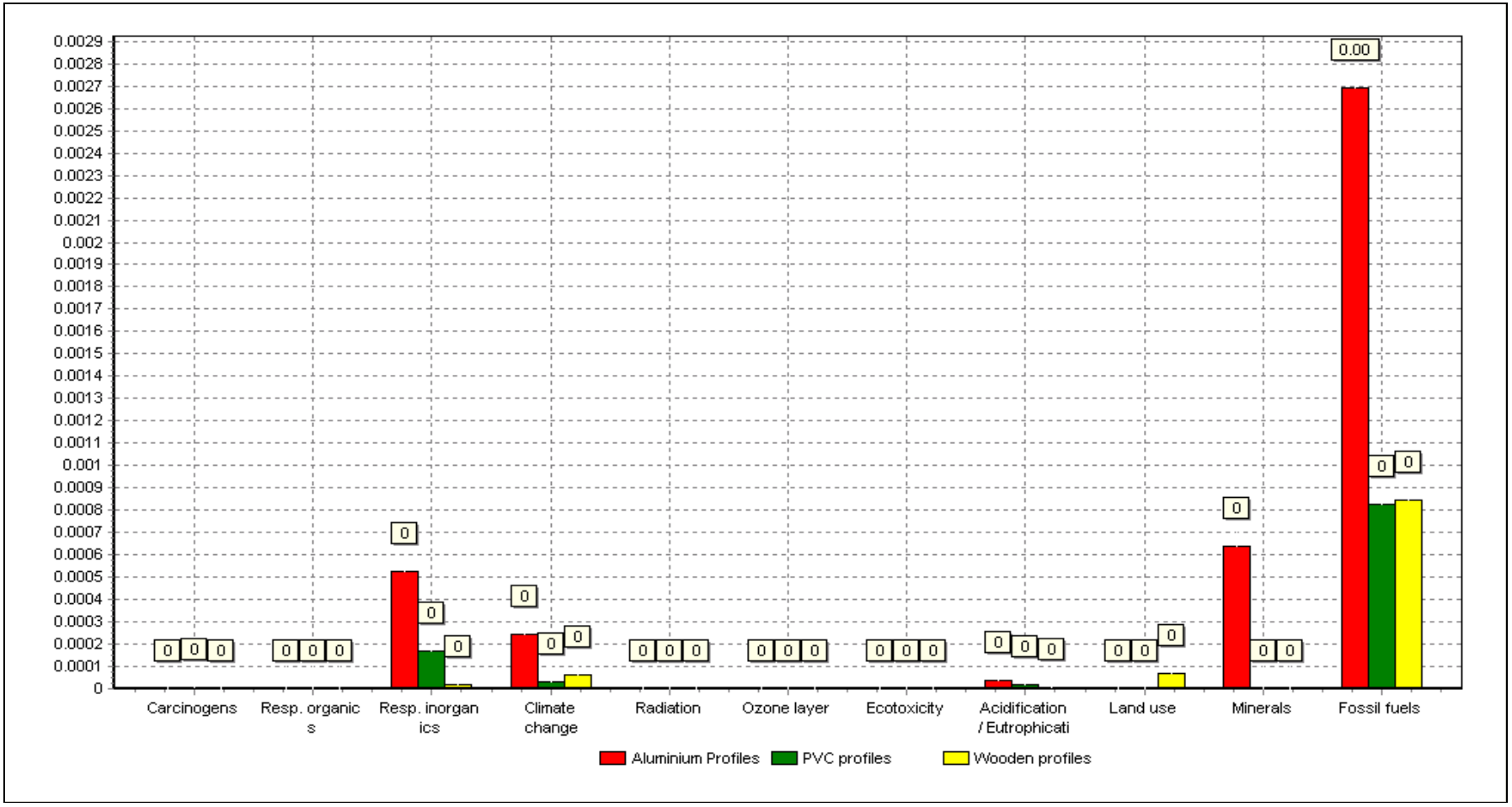
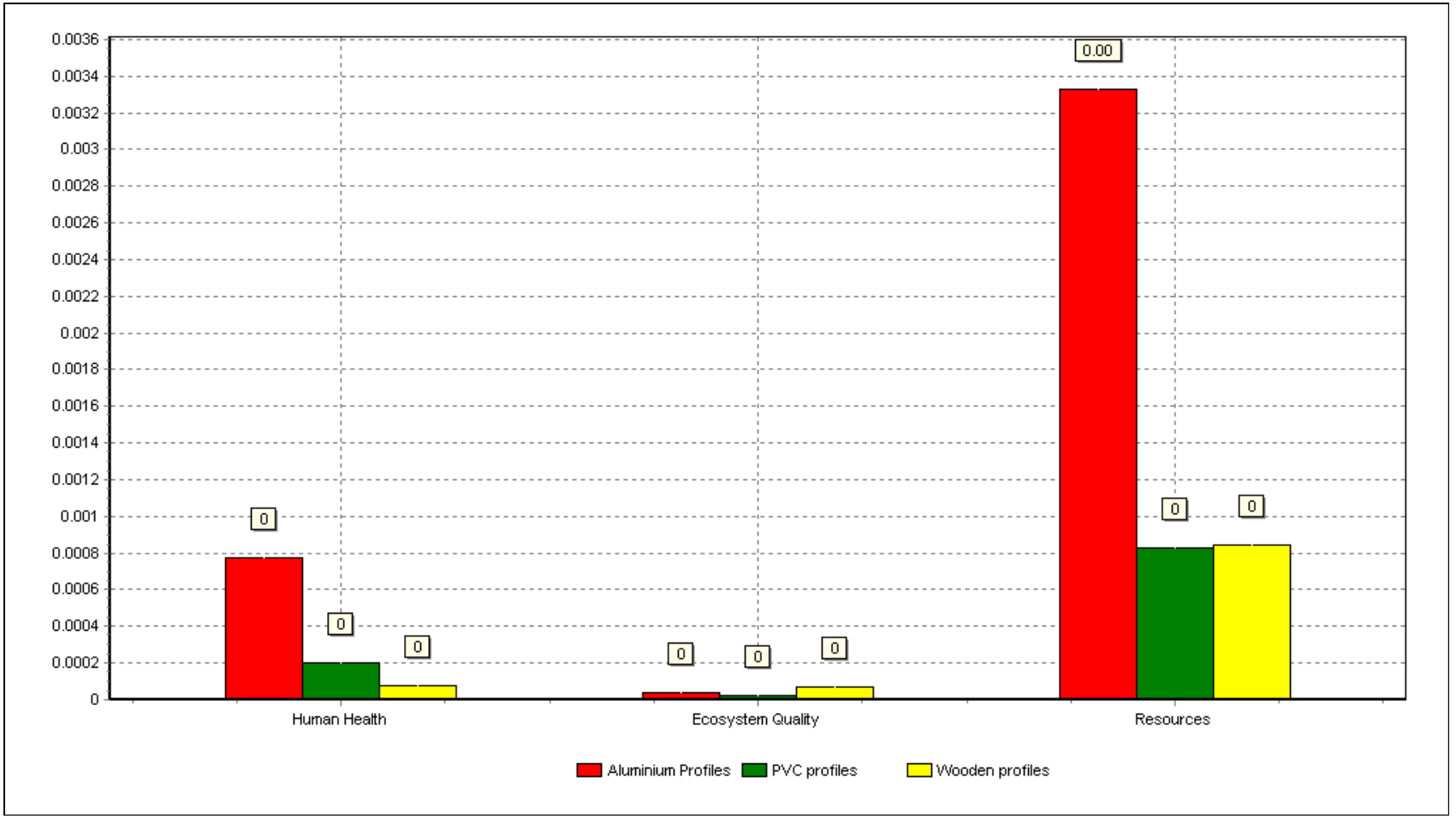


Figure 1.2: Life cycle assessment indicator scores for profiles (Damage category)



6.0 Life Cycle Interpretation

Aluminium Profiles

Aluminium profiles during their life cycle have an impact on Carcinogens, Respirable organics, Respirable inorganics, Climate change, Fossil fuels, Minerals, Acidification/Eutrophication and Ecotoxicity. The highest impact is observed on the Fossil fuels category. The other categories with major impact include Climate change and Respirable inorganics, Acidification/Eutrophication and Minerals.

The high impact on Fossil fuels is primarily due to the energy consumption in the first stage of the life cycle of the Aluminum profiles. Also, bauxite being a non renewable resource, the aluminium profiles have an impact on the impact category, Minerals. The release of Poly Aromatic Hydrocarbons (PAH) during the process of manufacturing of aluminium results in the impact on Carcinogens. The quantity released though is very minor and hence the impact is not very high.

Aluminum on recycling does not lose value and is 100% recyclable. Also, the energy requirement for recycling of Aluminium is much lesser as compared to manufacturing the profiles from virgin materials.

Wooden Profiles:

Wooden profiles during their life cycle have an impact on Respirable organics and inorganics, Climate change, Acidification/Eutrophication, Land use and Fossil fuels. However the impact on fossil fuels, climate change and land use is relatively high.

In comparison to PVC profiles, wooden profiles have lesser life resulting in higher impact. The impact on Climate change is primarily due to the increase in the carbon dioxide levels in the atmosphere resulting due to deforestation. Also, wooden profiles being heavier than PVC profiles have higher impact during the transportation stage. The impact of same is reflected across all the three damage categories.

PVC Profiles

The PVC profile during their life cycle have an impact on Fossil fuels, Acidification/Eutrophication , Respirable organics and inorganics and Climate change. The maximum impact is on Fossil fuels, though comparatively, this impact is lesser than that of aluminium but higher than that of wood. PVC profiles, as compared to aluminium profiles have the highest impact on the impact categories, carcinogens and respirable organics while the impact on respirable inorganics, climate change and acidification/eutrophication are lesser when compared to aluminium.

PVC profiles, being lighter than wooden or aluminium profiles and on account of having a longer life as compared to the wooden profiles result in comparatively lesser impact. Also, recycling of PVC reduces the load on the environment. It may be noted that the above results do not consider a waste disposal scenario through incineration for PVC profiles.Incineration of PVC may lead to the release of dioxins. The resulting carcinogenic effect is very high as compared to any of the other impacts categories and hence a waste genearation scenario considering incineration of PVC has not been evaluated.

Limitations:

The study is intended to be a comparative study for PVC profiles versus the alternatives. Hence, a completeness check has been done for the PVC profiles. The scores are to be considered in a relative sense and are meant to indicate higher or lower impact.